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Information and Guidelines for A Proposed Laboratory Accreditation and Product Certification Program for Photovoltaic Energy Conversion Systems

Douglas B. Thomas

Office of Testing Laboratory
Evaluation Technology
Office of Engineering Standards
National Bureau of Standards
U.S. Department of Commerce
Washington, DC 20234

August 1980

Prepared for
Solar Energy Research Institute
Golden, CO 80401

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U.S. DEPARTMENT OF COMMERCE, Philip M. Klutznick, *Secretary*

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NATIONAL BUREAU OF STANDARDS, Ernest Ambler, *Director*

TABLE OF CONTENTS

ERRATA SHEET
FOR
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Page 4, first paragraph, third line; change "verifi-cation" to "verification".

Page 16, third paragraph, first line; change "six" to "nine". Also on the same line, change "labortories" to "laboratories".

Page 22, first paragraph, seventh line; change "ealier" to "earlier".

Page 22, first paragraph, eighth line; change "initite" to "initiate".

Page 22, third paragraph, eighth line; change "ceritification" to "certification".

Page 22, fourth paragraph, second line, change "proagram" to "program".

Page 23, fifth line from the bottom; delete ", for example,".

Page 24, fourth line from the top; change "selction" to "selection".

Page 25, fourth line from the bottom of the page; change "contracts" to "contractee".

Page 27, sixteen lines from the bottom; change "Assistant Secretary for Science and Technology" to "Assistant Secretary for Productivity, Technology and Innovation".

Page 30, three lines from the bottom; change "Science and Technology" to "Productivity, Technology and Innovation".

Page 38, sixth line from the bottom; change "Value Engineering" to "VSE".

Information and Guidelines for a Proposed Laboratory Accreditation and Product Certification Program for Photovoltaic Energy Conversion Systems[1]

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Abstract

This report provides information and guidelines for use in preparing and implementing a laboratory evaluation and product certificate program for photovoltaic products, as required in the Department of Energy's work plan for the National Photovoltaic Energy Program.

The report presents an overview of the advantages and disadvantages of laboratory accreditation and product certification including economic factors that should be considered for such programs. Detailed information is also provided on the two national programs for accrediting laboratories, the Department of Commerce National Voluntary Laboratory Accreditation Program (NVLAP) and the American Association for Laboratory Accreditation (AALA). Information on the California and Florida state programs for laboratory accreditation and product certification of solar collector systems is given as examples of programs that have been in operation for several years. The organization of these programs and the experience gained by the program administrators may be useful in designing and implementing a program for photovoltaics. Also, accreditation and certification programs which are operated by other Federal and State agencies or professional and trade associations are listed for reference purposes.

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[1] This report was prepared under contract to the Solar Energy Research Institute (Subcontract No. XP-9-8028-1) in support of the Photovoltaic Performance Criteria and Test Standards (PC/TS) Project.

A number of steps are presented which need to be taken before any laboratory accreditation and product certification program for photovoltaics can be initiated. These steps include the selection of the photovoltaic products to be certified and the selection of pertinent performance criteria, levels of performance, and test methodology. Once these and other preparatory steps have been taken, a procedure is described to actually implement an appropriate program for photovoltaics.

Key words: Energy conversion; laboratory accreditation; photovoltaics; product certification; solar cells; solar collectors; solar energy

1. Introduction

The purpose of this report is to provide information and guidelines to the Solar Energy Research Institute (SERI) for its use in planning and implementing procedures for developing both laboratory evaluation and product certification programs for solar photovoltaic energy conversion systems. Fostering the development of such programs is one of the four tasks for the Photovoltaic Performance Criteria and Test Standards (PC/TS) Project[2] of SERI. This project was created to be responsive to the Solar Photovoltaic Energy Research, Development and Demonstration Act of 1978 (PL-95-590). Pertinent to this report is the part of PL-95-590 which states that "manufacturers of photovoltaic components and systems shall have their products tested in order to provide certification that such products shall conform" to appropriate performance criteria that the Secretary of Energy shall determine, prescribe, and publish.

This report is divided into three basic parts: (1) an overview of laboratory accreditation and product certification, (2) a review of national, state, professional and trade association programs for laboratory accreditation and product certification, and (3) laboratory accreditation and product certification for photovoltaic systems.

An overview of laboratory accreditation and product certification is presented to enlighten the reader about the advantages and disadvantages of these concepts; how testing laboratories, manufacturers, and consumers view accreditation and certification; how the costs of these programs are covered; and the improved product reliability that is expected to result from product certification and laboratory accreditation.

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[2] Nuss, Gary R., Interim Implementation Structure for Development of Performance Criteria and Test Standards for Photovoltaic Systems, SERI/MR-61-270, August 1979.

Detailed information is presented on the Department of Commerce National Voluntary Laboratory Accreditation Program (NVLAP). The information includes laboratory evaluation criteria and methodology, agreements by the laboratory, accreditation fees, and laboratory monitoring procedures. Also, information is provided on the American Association for Laboratory Accreditation (AALA) program concerning testing disciplines, accreditation requirements, fees and laboratory assessments. This program was initiated by the American Council of Independent Laboratories and is promulgated through the private sector. The two laboratory accreditation and certification programs for solar thermal collectors established by the states of California and Florida are also described in the report. The experiences gained in these programs are described briefly because they may be helpful to SERI in establishing such programs for photovoltaic systems. A large number of other Federal, state, professional, and trade association programs for laboratory accreditation and product certification are listed and referenced.

Information and recommendations are included for establishing an accreditation and certification program for photovoltaic systems. As an alternative to a laboratory accreditation program, information is provided on "approved" laboratory programs. Some basic questions are raised concerning the need for photovoltaic standards and test methods, costs of operating the programs, the number of laboratories capable of testing the product, the manufacturer's role in the certification process, and warranties for certified products. Finally, instructions are given for applying for a laboratory accreditation program through NVLAP or AALA and an organizational plan is suggested for interfacing the necessary components of a laboratory accreditation and certification program for photovoltaic systems.

The Electron Devices Division (EDD) of NBS is under subcontract to SERI to provide assistance in achieving the tasks under the PC/TS project. EDD selected the Office of Testing Laboratory Evaluation Technology to provide this report.

2. An Overview of Laboratory Accreditation

2.1 What is Laboratory Accreditation?

The accreditation of a laboratory represents an official recognition that the laboratory has the necessary personnel, physical resources, and quality assurance needed to perform a specific testing activity adequately. The process of accreditation involves the assessment of a laboratory's testing capability by an accrediting authority using criteria that represent the essential requirements for a laboratory's performance.

Accreditation that results from a properly administered program is testimony to the fact that the laboratory had at the time of its evaluation the attributes that were deemed necessary to properly conduct the testing for which it is accredited. A properly administered program not only benefits the

accredited laboratory by recognizing its competency but also verifies for the user that the laboratory is capable of providing testing services that are accurate and reliable. Without this verifi- cation of a laboratory's capabilities, laboratory selection may have to be based on "tips" from other users or on advertising that represents a self-evaluation by the laboratory. Sometimes, the lack of a laboratory's proficiency is realized long after the test results have been received and paid for by the user. If the user has strong reasons to believe that the testing had not been properly conducted, his only recourse may be expensive and time-consuming litigation. An additional asset of accreditation involves the competition between laboratories offering similar services. Accreditation is helpful to laboratories in their effort to establish and maintain a high standard of testing and to limit competition from unqualified laboratories and laboratories which sacrifice testing quality to increase profit.

It should be emphasized that although a laboratory has an acceptable testing capability at the time it is evaluated for accreditation, its capability may change following accreditation. Because of this possibility, an accreditation program must include features for monitoring a laboratory's performance on a continuing basis to insure that its proficiency is maintained after accreditation. Without a monitoring program, a laboratory's proficiency can decrease while its accreditation status remains valid. This subjects the user of the laboratory's services to a fraudulent situation since he believes that his tests are being conducted at the level of competence the laboratory had at the time it was evaluated for accreditation. Details concerning the monitoring of accredited laboratories and other elements of accreditation will be presented in subsequent sections.

The status of accreditation is a strong incentive for a laboratory to maintain a high level of testing proficiency. If a laboratory loses its accreditation, the news of the loss quickly reaches its clients who then realize that something is "wrong" with the laboratory. This loss of accreditation invariably leads to the loss of business. Logically, a laboratory in this situation will be eager to correct the problems that caused the loss of accreditation in order to restore the confidence and continued patronage of its clients.

A common misconception concerning laboratory accreditation is the belief that accreditation represents a guarantee that the laboratory's testing is always conducted properly and that the test results are always accurate. This fallacy is easily recognized when one realizes that human and equipment performance can never be guaranteed. Accreditation does, however, greatly increase the probability that testing is conducted properly and accurately. Also, the term accredited laboratory is sometimes confused with certified laboratory. Certification implies a warranty or guarantee. As previously mentioned, the performance of laboratory personnel and equipment cannot be guaranteed. Thus, the term certified laboratory is a misnomer. The term "laboratory certification" is properly used if it refers to the testing process conducted by a laboratory in the certification of products.

2.2 The Elements and Economics of Developing an Accreditation Program

A number of basic elements are needed to constitute a laboratory accreditation program. They include:

(a) defining the program scope, i.e., identification of the product and test methods to support an accreditation program,
(b) evaluating the technical integrity and appropriateness of the test methods associated with the program,
(c) establishing laboratory accreditation criteria,
(d) establishing examination methodology for evaluating laboratories (questionnaires, on-site visits, proficiency testing, etc.),
(e) establishing minimum precision, accuracy and repeatability requirements for test equipment, facilities, and procedures,
(f) developing evaluation documents (forms, questionnaires, examination sheets, etc.),
(g) sending questionnaires to laboratories to determine their testing capabilities,
(h) securing and training laboratory examiners,
(i) scheduling and conducting on-site examination of laboratories,
(j) evaluating laboratory examination data from questionnaires and on-site visits,
(k) developing and implementing proficiency testing programs (secure, characterize, and distribute test samples),
(l) evaluating proficiency test data, and
(m) overall management of the accreditation program.

The development of these elements and their management and implementation may involve large expendatures in time and funds. Any agency or association that is considering a laboratory accreditation program should assess these factors.

The costs of an accreditation program are usually underwritten, either fully or partially by the accrediting agency, the program requestor, the accredited laboratories, or the manufacturers of the products tested by the accredited laboratories. Any costs that are incurred by the laboratories or the manufacturers are usually passed along to the users of the laboratory's services or to the manufacturer's products. The rational used to justify an accreditation program may determine which of the above groups will finance the program. For example, if an agency determines that a specific product can be hazardous if it is not manufactured in accordance with established standards, it may bear the full cost of a laboratory accreditation (and product certification) program as a means of minimizing the possiblity of consumers buying and using an unsafe product. The American Association of Motor Vehicle Administrators have implemented a program for the evaluation and approval of laboratories that test motor vehicle safety equipment. This Association bears the full cost of the program except for a fee each laboratory pays for on-site inspections by Association representatives.

One of the disadvantages of a laboratory accreditation program for the certification testing of products concerns the cost of evaluating more applicant laboratories than is required. If 15 laboratories are needed to handle the required testing and 30 laboratories apply for accreditation, the cost of evaluating the additional laboratories would add to the total cost of the program. This total cost is reduced somewhat if the laboratories are required to pay evaluation fees but rarely do these fees cover the full cost of the evaluations.

An example of a cost-sharing accreditation program is the Department of Commerce National Voluntary Laboratory Accreditation Program (NVLAP). In this program, much of the initial costs for establishing accreditation criteria and examination methodologies for a given testing regime are covered by Department of Commerce funds. Once a program becomes operational, annual accreditation fees collected from participating laboratories may cover the cost of maintaining the program.

If all or part of the costs of an accreditation program are recovered by fees charged to the laboratories, the laboratories will, very likely, base their decision to become accredited on the presumption that all or most of the accreditation costs can be recovered by an increased volume of testing or through increased fees. The total costs incurred by a laboratory contemplating accreditation not only include annual fees but also all costs associated with required documentation, on-site examinations, proficiency testing, etc. Usually, the latter costs are significantly larger than the accreditation fees. From the laboratory's point of view, the decision to become accredited is strongly influenced by the need for proficient testing of the respective class of products, the number of laboratories that would probably apply for accreditation, the number of users who may seek the services of accredited laboratories, and the anticipated volume of testing. One of the worse fates that could happen to a voluntary accreditation program is a total lack of requests from laboratories for accreditation because the economics are not favorable to the laboratories.

If an agency has determined a need for accredited laboratories, it may decide to (a) establish its own program, (b) use one of the national programs i.e., NVLAP or AALA[3] (see Sections 4.1 and 4.2) that accredit laboratories, provided certain program requirements are met, or (c) use laboratories that have been accredited by another agency for testing a product of mutual interest. An example of the latter would be a requirement by the State of Arizona that all commercial models of solar collectors sold or used in the State must be tested and certified by one of the nine laboratories that have been accredited by the California State Energy Resources Conservation and Development Commission (see Section 5.1).

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[3] The American Association for Laboratory Accreditation (AALA) is a non-profit organization composed of trade and professional organizations with the purpose of accrediting laboratories in various areas of testing.

2.3 Time-Factor Considerations

The time factor is an important consideration in any decision to establish a laboratory accreditation program. Many of the elements in a program can only be developed sequentially. The training of inspectors, for example, cannot begin until the criteria and methodology for the examination of laboratories have been established. This factor extends the total time required to develop an accreditation program.

An agency that developes its own program for accrediting laboratories (nationally) can assume that it will take from two to three years from the time the program is initiated to the time the first laboratory is accredited. This estimate is based on the time periods that were required to implement the NVLAP and AALA programs to their present stage of progress. The two-to-three-year period could be decreased somewhat if the agency were to adopt applicable criteria and methodologies that have been successfully used in other accreditation programs.

If an agency decides to establish accredited laboratories through a national program such as NVLAP or AALA, a period of approximately one year can be assumed for developing and implementing a specific program. The period may vary somewhat depending on the scope of the program. If NVLAP is used and the requesting agency is a Federal agency or a standards- writing body, procedures exist for reducing the time by approximately four months (see Appendix A, Section 5).

If an agency fulfills its requirements for accredited laboratories by adopting the laboratories accredited by another agency, a period of from three to six months may be required to implement the program.

2.4 Alternatives to Accreditation

Any accreditation program that requires participating laboratories to pay fees must be economically favorable to the laboratories. If this is not the case, the program may fail from lack of participation.

An alternative form of accreditation is a laboratory "approval" program. This type of program is similar to a laboratory accreditation program but there are some significant differences. These differences are:

(a) The agency has full control over the numbers of laboratories that are approved and usually approves only enough laboratories to handle the anticipated volume of testing. (Note: one laboratory may be sufficient to handle all of the testing in a specific program.)
(b) Because of the limiting factor of (a) above, the "approved" laboratories are almost assured of testing contracts.

(c) An "approved" laboratory program generally requires less time and expense to put into operation because there is no obligation to evaluate all laboratories that may apply.
(d) An "approved" laboratory generally does not pay annual fees for its approved status.

An example of an "approved" laboratory program is the International Association of Chiefs of Police (IACP) compliance testing program for law enforcement equipment. IACP, the Law Enforcement Standards Laboratory (NBS) and the Office of Testing Laboratory Evaluation Technology (NBS) established a program to solicit and evaluate independent laboratories which are capable of testing selected categories of law enforcement equipment.

The program evaluates applicant laboratories by questionnaire information, on-site inspections, and preliminary testing of specific samples of law enforcement equipment. Generally, two laboratories are chosen for each equipment category. The testing is conducted in accordance with NIJ[4] performance standards established for each equipment category. Specific models in each category are either obtained from the manufacturer or purchased from suppliers by IACP. These models, after being tested by the "approved" laboratories are listed on IACP qualified products lists. The lists specify which models pass or fail the respective NIJ standard requirements. The qualified products lists are distributed by IACP to police departments in the U.S. and foreign countries for the purpose of assisting them in the selection of reliable law enforcement equipment.

Other "approved" laboratory programs are operated by the Defense Supply Agency of the Department of Defense for testing a variety of products and materials and the Agriculture Department for the testing of meats and poultry.

3. An Overview of Product Certification

3.1 What is Product Certification?

Certification can be defined as an act of issuing an official warranty, certificate or mark which guarantees that a product conforms to specific standards or specifications. However, the meaning of the word "guarantee" should be clarified. The guarantee implied by most product certification programs is a statistical guarantee and not a guarantee that each product unit will comply with the standards or specifications pertinent to the certification. The only way a certification sponsor could attempt to guarantee each unit of a particular product model would be a 100 percent compliance testing program in which every unit is tested for compliance. This amount of testing

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[4] National Institute of Justice, U.S. Department of Justice

would be costly and probably would not represent a 100 percent guarantee since it is unlikely that any laboratory can conduct such testing without occasional error. Also, if any of the required tests are destructive, then 100 percent compliance testing is not possible.

Certification testing should be distinguished from compliance testing. Certification testing is the testing required to certify a particular manufacturer's model of a product. The testing is a confirmation that the design and performance of the units of the model tested meet the specifications covered by the certification. The certification of a product model is an implication that if the units of the model used in the certification testing meet the required specifications, then all units of the model (of the same design) subsequently manufactured should also meet the required specifications. Compliance testing is used to confirm that specific units of a certified product model meet specifications or is used to determine if non-certified product units meet specific requirements. Thus, certification testing is a form of compliance testing but compliance testing is not certification testing.

The certification of a product model usually includes a written warranty or at least an understanding that any product unit which fails to meet specifications will be repaired or replaced by the manufacturer or the certifier at no cost to the user. The objective of a product certification program is to improve the overall compliance of a particular model or class of products and is not a guarantee for each product unit.

A certifier, in the absence of a formal laboratory evaluation program, may select one or more independent laboratories to serve as certifying laboratories in the certification testing of products. These laboratories may be accredited or approved laboratories from other programs or they may be laboratories that the certifier selects on the basis of their established reputation in a particular field of testing. As an alternative, the certifier may establish an accredited or "approved" laboratory program for use in the certification testing. The certifying laboratory usually tests a specified number of units of a product model as furnished by the manufacturer. If a certain percentage of the tested units meets specification, the model is certified and units are placed on the market.

The question concerning the use of manufacturer's or independent laboratories for the certification and compliance testing of products is one that has been debated for many certification programs. Those who maintain that both types of laboratories may be used, argue that both must comply with the laboratory criteria and monitoring requirements of the respective program and thus both should be equally competent and reliable to conduct the required testing. The opposing point of view maintains that only independent laboratories should be used because (a) certification and compliance testing by a manufacturer's laboratory can result in biased testing, (b) the independent laboratory has no economic interest in the sale of the product, and (c) third-party independent testing is needed to verify the quality control compliance testing conducted by the manufacturer. The reasoning that

supports the contention that both types of laboratories should be eligible to conduct certification and compliance testing is valid. However, the opposing reasoning is also valid and represents a testing system which assures the user of the certified product that it has been tested by a laboratory that is independent of the manufacturer and greatly decreases the chances of biased testing. There is no simple solution to this controversy and each certification program administrator must assess the advantages and disadvantages of each approach and make a decision accordingly.

3.2 Economic Consideration

The increased probability of product compliance through certification is advantageous to the product user but it also adds to the cost of each unit. The cost of certifying a particular product may be excessive because of poor product design, low quality materials or poor quality control during the manufacturing process. If this is the case, frequent compliance testing is needed to assure a high probability of product compliance. Also, the per-unit cost of compliance testing can be significant if the product units are expensive and the testing is destructive.

If the compliance testing of electronic switches, for example, is non-destructive and the cost of testing each switch is small compared to the cost of the switch, it would be advantageous to test a large percentage (perhaps even 100 percent) of the switches that eventually reach the user. Conversely, the compliance testing of police body armor is expensive, destructive, and the cost of each unit varies from approximately $100 to $500. Thus, the number of units that can be tested must be limited or the total costs become prohibitive.

An example of an extreme case of product non-compliance and the importance of compliance testing is the IACP body armor compliance testing program. Test results showed that approximately 50 percent of the armor units failed to meet standard specifications. This high failure rate was attributed mainly to improper armor design. Careful analysis of the armor units tested by IACP resulted in the conclusion that an improvement in materials and design would have significantly increased the ballistic resistance of many of the models tested. According to an IACP official, the body armor failure rate of approximately 50 percent could have been reduced to a few percent if certain improvements in material and design had been implemented by the manufacturers. These improvements would have resulted in a slight increase in the manufacturing costs but the increase would have been less then the cost of the compliance testing required for units that have a 50 percent failure rate.

Many products are designed and manufactured to be highly competitive by meeting minimum standard requirements or minimum requirements established by the product user. If a manufacturer can consistantly produce a product that just meets the minimum requirements with none of the units ever falling below the minimum he has achieved the best of two worlds. His production costs are at a minimum and his rejection rate is zero. However, the production control

needed to achieve this optimum is rare and difficult to achieve. Although a product can be designed and manufactured to meet specific minimum requirements, certain controllable and uncontrollable variables during the manufacturing process will cause a significant number of units to fall below the minimum requirements. If these unacceptable units are not identified during the manufacturing process and no compliance testing is conducted before they are placed in service, the user is bound to experience reduced product performance.

A program of product certification with follow-up compliance testing by an independent accredited or approved laboratory is a major step toward insuring a high probability of product compliance. Once a product model has been tested and certified, the first logical step needed to assure high probability of product compliance for units continuously produced by the manufacturer is compliance testing by the manufacturer. Although compliance testing by most manufacturers is conducted properly and thoroughly, the pressures on the manufacturer to hold down production costs and to beat competition can result in test results that are incomplete or deceptive. To eliminate this possibility, a product certification program should include compliance testing by the certifying laboratory or some other independent laboratory of randomly selected samples from the manufacturer's production lots. The number of samples selected and tested from each lot should be determined in accordance with established sampling plans[5] that correlate the number of samples with desired product conformity.

In view of the above factors, it can be seen that optimum product compliance can be achieved through:

(a) proper design, materials specification, and quality control during the manufacturing process (a form of built-in reliability),
(b) certification that the product (model) meets specified requirements, and
(c) compliance testing to assure continued compliance of the product units produced by the manufacturer.

3.3 Certified Product Labeling

Once a product has been certified, some means of identifying the product in the wholesale and retail market is required. This is usually accomplished by certification labeling. The sponsor of the program or the certifying laboratory designs a label (or uses an established universal label) that is

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[5] ASTM E122-72, Standard Recommended Practice for Choice of Sample Size to Estimate the Average Quality of a Lot or Process.
MIL-STD-105D, Sampling Procedures and Tables for Inspection by Attributes, Department of Defense, 1963.

affixed to each product unit and usually identifies the certification sponsor and/or the certifying laboratory. Also, the label may list, by reference, the standards or specifications that the product meets. For practical purposes, the labels are usually placed on the respective products by the manufacturer.

Although a certification label on a product is useful for the purpose of identification, the label itself can present problems. After a product model has been certified for a period of time, it is possible that an error or quality control problem during the manufacturing process results in a large number of units being labeled before the error or problem is discovered. If a large quantity of these units do not meet specifications and the manufacturer's compliance testing was not effective in detecting the units, the units may be difficult or almost impossible to identify after they are shipped to warehouses, buyers or users. The problem of identifying specific units is eased somewhat if the units are marked with lot numbers or serial numbers. However, a product certification program is weakened considerably if non-complying units are labeled and placed on the market even though the units can be quickly identified and recalled. If the units cannot be identified, the certification of the product is of little value to the user. This is just another example of the importance of compliance testing by the manufacturer and also by an independent laboratory. Once a product model has been certified, each level of compliance testing is added insurance that labeled units meet certification specifications.

3.4 Certified Product Lists

Although a certified product can be identified by means of a label, an additional identification system is needed for the groups of people who specify or procure various products. This type of identification can be achieved by certified products lists (CPL). These lists may include the following information.

(a) Class or type of product
(b) Model name, number, style, or other designations of units that are in compliance
(c) Name and address of the manufacturers of the product models
(d) Standards or specifications with which the product models are in compliance
(e) Date of the initial certification of each model
(f) The range of lot numbers or serial numbers of certified models (requires up-dating)
(g) Model name, number, style, or other designations of units that were tested but were not in compliance[6]
(h) Product model modifications since the initial certification (requires up-dating)

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[6] Some certified products lists do not list this information.

Certified products lists offer a convenient means of summarizing product compliance information and up-dating status reports concerning a particular certification program. A CPL, if up-dated at frequent intervals, provides (1) current information to manufacturers, suppliers, contractors, and retailers regarding product models that have been added or removed from the list; (2) references to new product standards or specifications; (3) the names of new companies that have entered the product field and; (4) information on product modifications by the manufacturer.

Certified Products Lists should be established, maintained, and distributed by the certification program sponsor. Generally, one list is established for a particular class of products although some product classes cover such a wide area of different models or types that lists are established for various sub-classes of a product.

4. National Laboratory Accreditation Programs

4.1 The National Voluntary Laboratory Accreditation Program (NVLAP)

The National Voluntary Laboratory Accreditation Program (NVLAP) is a system to examine, upon request, the professional and technical competence of private and public testing laboratories that serve regulatory and non-regulatory product and certification needs. NVLAP was developed in cooperation with the private sector and is administered by the Department of Commerce. The intended goal of the program is to serve the needs of industry, consumers, the Government, and others by accrediting testing laboratories that comply with criteria established for a particular testing regimen.

Accreditation programs for testing laboratories which render a service relative to specific products are established by the Secretary of Commerce through a process known as "Finding of Need." This process is initiated by a request to the Secretary to establish a Laboratory Accreditation Program (LAP).

Any person, group, business, or organization can request a LAP for a specific product but the request must comply with the procedures set out in the Federal Register Notice dated February 25, 1976, (Title 15, Code of Federal Regulations, Part 7).

In accordance with these procedures, a request for a LAP must provide the following.

(a) Identification of the product;
(b) Text of an applicable product standard(s);
(c) Text of a test method(s) if not included in the product standard(s);
(d) The basis of need for accrediting laboratories that test the product including;
    (d1) An estimate of the number of laboratories that may wish to be accredited;

(d2) An estimate of the number of users of such accredited laboratories;
(d3) Whether the accreditation of laboratories that test the product will benefit the public interest;
(d4) Whether there is a national need to accredit laboratories that test the product beyond existing laboratory accreditation programs in the public or private sector;

(e) A standard for the product that is deemed by the Secretary of Commerce as being important to commerce, consumer well-being, or the public health and safety;

(f) A valid testing methodology for ascertaining conformity to the standard(s) of the specific product involved, and

(g) Feasibility and practicality of accrediting laboratories that test the specific product.

Additional information concerning NVLAP is presented in Appendix A.

4.2 The American Association for Laboratory Accreditation (AALA)[7]

The American Association for Laboratory Accreditation (AALA) is a private non-profit organization which has been established to accredit laboratories operated by individuals, partnerships, corporations, universities, research organizations, associations, and government agencies. At the time of this writing, the AALA program is in the formative stages and is not yet operational. Evaluation criteria have not yet been developed; however, the association intends to accredit laboratories on the basis of criteria relating to personnel, equipment, operational processes, quality assurance procedures, and other relevant considerations.

The AALA program is supported by various sponsoring organizations. The board of directors consists of representatives of the association membership and these directors appoint the members of the Council of Accreditation, the Executive Director, and others. The Council of Accreditation consisting of twelve members is comprised of four members representing organizations that provide laboratory services, four members representing organizations that use laboratory services, and four members from general interest organizations.

The technical activities of the Association are undertaken by Accreditation Advisory Committees established by and directly responsible to the Council of Accreditation. Each Advisory Committee controls the Association's activities in one of the disciplines of testing in which laboratories are accredited (See appendix C).

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[7] The National Bureau of Standards has made no formal evaluation of the AALA program including the methodology used to accredit laboratories. The information presented in this Section represents a summary of the literature published by AALA and does not represent an appraisal or endorsement by the National Bureau of Standards.

Accreditation Advisory Committees are assisted in the inspection and evaluation of laboratories by panels of specialist inspectors. These inspectors visit applicant laboratories to appraise the adequacy of facilities, personnel, equipment, and test procedures, and to discuss the work and problems of the laboratories with their management and staff. The inspectors work for the Association as experts in specific disciplines of work and are briefed for each assignment by the Accreditation Advisory Committee under whose direction they act.

Additional information concerning AALA is presented in appendix B.

5. State Laboratory Accreditation and Product Certification Programs For Testing Solar Collector Components and Systems

5.1 State of California Energy Commission Program

5.1.1 Laboratory Accreditation Program

In 1978 the California Energy Commission (CEC) implemented a program for laboratory accreditation and product certification for solar collector components and systems. The procedures, application documentation, and laboratory criteria for their accreditation program are presented in the CEC document, "Standards and Procedures - Accreditation of Testing Laboratories for Solar Components and Systems," May 31, 1978. Criteria are presented with respect to:

(a) Organization and Management
- Personnel Requirements
- Personnel Records

(b) Human Resources
- Personnel Requirements
- Personnel Records

(c) Physical Resources
- Test Resources
- Support Equipment
- Records
- Substituted Equipment
- Storage

(d) Quality Assurance
- Instrument Inventory and Records
- Calibration Laboratory
- Recall System
- Instrument Label
- Human Resources
- Technical Library
- Quality Control Manual
- Training Program

(e) Conditions of Accreditation
- Application
- Renewal of Accreditation
- Modification of Accreditation
- Grounds for Revocation
- Resubmittal of Application for Accreditation
- Fees and Charges
- Laboratory Appeals Procedures

Accreditation by CEC covers a two-year period. During the evaluation of a laboratory prior to accreditation, a CEC assessor conducts a complete on-site inspection of the laboratory. During the inspection, the assessor examines human and physical resources, quality control procedures, and record keeping practices. In addition, the laboratory is required to conduct all or portions of the tests for which the laboratory has requested accreditation. After accreditation has been granted, an assessor may make unannounced on-site visits to the laboratory to assure that it continues to meet all criteria requirements. Also, the laboratory must participate in a proficiency test program that involves the testing of samples or components that are prepared by CEC.

In the CEC program, any independent laboratory can apply for accreditation whether it is located in California, in another state, or in a foreign country. Applicant laboratories do not pay a fee for accreditation but may be required to pay the costs of on-site inspections.

As of June 15, 1978, CEC had accredited six labortories, three of which are located in California and one in each of the states of Arizona, Florida and Alabama.

5.1.2 Equipment Certification Program

A certification program for solar energy equipment (products) was initiated by the California Energy Commission concurrently with its laboratory accreditation program. The scope of the program includes the certification of solar energy equipment in accordance with the ASHRAE Standard 93-77, "Method of Testing to Determine the Thermal Performance of Solar Collectors," and the NBS document NBSIR 77-1305A "Provisional Flat-Plate Solar Collector Testing Procedures." The certification criteria classifies all equipment that manufacturers may submit for certification as either "Standard Solar Equipment" or "Innovative Solar Equipment." The "standard" equipment is defined as equipment that was designed and tested in accordance with the two above mentioned standards. The "innovative" equipment has design and performance characteristics that deviate from the "Standard" equipment and cannot be fairly and adequately evaluated in accordance with the two program standards.

The program procedures, manufacturer's requirements, and equipment requirements are specified in the CEC document, "Certification Criteria for Solar Energy Equipment," June 15, 1978. The CEC document includes program forms covering the following areas.

(a) Application for Certifiction
(b) Product Description
(c) Product Installation
(d) Product Application
(e) General Requirements
(f) Specific Requirements
(g) Minimum Application Data and
(h) Certification Label Information

As of April 12, 1979, 54 solar collector models representing 26 manufacturers have been certified under the CEC program.

5.2 State of Florida Solar Energy Center Program

In 1976, the Florida Legislature enacted the Solar Energy Standards Act which directs the Florida Solar Energy Center (FSEC) to develop standards for solar energy equipment manufactured or sold in the state, to establish criteria for determining the performance of solar energy equipment, and to maintain a testing facility for evaluating solar energy equipment performance.

As a result of this legislation, FSEC established a solar collector certification program with specific requirements for laboratories that conduct certification testing in accordance with prescribed performance standards. The program requires that solar collectors be tested for compliance with FSEC Standard 77-5 which is a modification of the ASHRAE Standard 93-77. FSEC Standard 77-5 establishes test methodology in the following areas of solar collector performance.

(a) Collector Time Constant Determination
(b) Thermal Efficiency Determination
(c) Incident Angle Modifier Determination
(d) Pressure Tests
(e) Exposure Tests
(f) Spray Tests
(g) Thermal Performance Recheck
(h) Collector Performance Rating

The FSEC certification program requires all solar collector certification testing to be conducted by one of the following types of labortories.

(a) The laboratory at the Florida Solar Energy Center,
(b) A laboratory evaluated under the Air-Conditioning and Refrigeration Institute Foundation (ARIF) contract study for NBS[8], or
(c) Any independent laboratory that provides the following
- A diagram of the test configuration used, the specification sheets on all measuring and recording equipment, and copies of the test procedures
- A signed affirmation from a responsible official of the laboratory or a registered professional engineer that the test methods used meet the standards set forth in Section 7.0 of FSEC 77-5
- Permission for FSEC personnel to visit the test facility and observe test procedures.

Manufacturers who wish to submit solar collector models to FSEC for certification are required to pay specific fees for testing and certification. The fee for the complete certification sequence in accordance with FSEC Standard 77-5 is $1,350 per model. If a model has been tested for thermal performance by another organization whose test procedures and results are accepted by FSEC, the fee for certification is $875. For models that have been tested and inspected in accordance with FSEC 77-5 by another organization whose results are acceptable to FSEC, the certification fee is $300. If a manufacturer has had a collector model certified under the NBS test method NBSIR 74-635[9] and wishes to have it certified in accordance with FSEC 77-5, the fee is $150.

For each collector model certified by FSEC, the manufacturer receives a supply of certification labels to be attached to all units placed in service or on the market. Once a collector model has been certified by FSEC, the manufacturer agrees to:

(a) Represent a collector as certified only when it is manufactured of the same materials and in accordance with the same specifications and drawings as the collector that was originally submitted for certification testing;
(b) Permanently affix a nameplate to each model unit which indiates the manufacturer's name, address, model number, maximum operating pressure, and voltage and current requirements;

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[8] Niessing, W.J., "Laboratories Technically Qualified to Test Solar Collectors in Accordance with ASHRAE Standard 93-77: A Summary Report," NBS Report NBSIR 78-1535, November 1978.

[9] The report by J. E. Hill and T. Kusuda, "Method of Testing for Rating Solar Collectors Based on Thermal Performance," 1974; NBSIR 74-635, was prepared for the National Science Foundation.

(c) Notify FSEC of changes in collector materials or construction and accept FSEC's judgment relative to whether these changes constitute a model change requiring re-testing;
(d) Provide copies of the FSEC Certification Summary Information Sheet upon request;
(e) Permit FSEC to select at any time a unit of the certified model offered for sale or on display, for the purpose of re-testing at FSEC expense to verify the performance and compliance of the unit with the original certification test data.

6. Other Federal, State, Professional, and Trade Association Programs For Laboratory Accreditation

In addition to the National and State laboratory accreditation programs described in Sections 4 and 5, a variety of other programs are sponsored by Federal and State agencies and by professional and trade associations. The following list of these programs was presented in the Hyer publication.[10]

Federal Goverment Programs

Agriculture - meat and poultry laboratories
Defense - personnel support equipment, textiles
Defense - Defense Logistics Agency (DCASR)
Defense - Defense Electronics Supply Centre (DESC)
Defense - Navy, shock testing facilities
Environmental Protection Agency - public water testing labs
General Services Administration - Federal Supply Services, procurement
Health, Education and Welfare - Center for Disease Control
Health, Education and Welfare - milk testing laboratories
National Aeronautics and Space Administration - space vehicle components
Tennessee Valley Authority - energy materials and products
Transportation - Coast Guard, approved safety devices
Transportation - Federal Aviation Administration
International Association of Chiefs of Police - law enforcement equipment[11]
Metallurgical Engineers of Atlanta, Inc. - carpeting[12]
Associated Laboratories, Inc. - carpeting[12]
ETL Testing Laboratories, Inc. - carpeting[12]

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[10] "Principal Aspects of U.S. Laboratory Accreditation Programs"; Charles W. Hyer, The Marley Organization, Inc., Ridgefield, Connecticut. January 24, 1979. Order No. 816656; U.S. Department of Commerce, Washington, DC 20234.

[11] Funded by the Department of Justice for approved product compliance purposes.

[12] Operates on the basis of a Housing and Urban Development approval of administrator.

State and Local Government Programs

California - thermal insulation testing laboratories
Connecticut - water and allied analysis laboratories
Kentucky - public water supply analysis laboratories
Massachussets - concrete testing laboratories
New York - water testing laboratories
North Carolina - electrical safety testing laboratories
Ohio - flammability, building products
Oregon - electrical safety testing laboratories
Pennsylvania - Department of Agriculture - dairy products
Washington - electrical safety testing laboratories
Dade County, FL - building products testing laboratories
Altanta, GA - electrical safety testing laboratories
Chicago, IL - electrical safety testing laboratories
Los Angeles, CA - electrical safety testing laboratories
Oakland, CA - electrical safety testing laboratories
Portland, OR - electrical safety testing laboratories
Richmond, VA - electrical safety testing laboratories
San Francisco, CA - electrical safety testing laboratories

Professional and Trade Association Programs

Air Diffusion Council - product certification related laboratories
Air Moving & Control Association - product certification related laboratories
American Association of Motor Vehicle Administrators - automotive safety products testing laboratories
American Industrial Hygiene Association - industrial hygiene laboratories
American Society of Mechanical Engineers - valve testing laboratories
American Society of Mechanical Engineers - pollution prevention devices, components testing laboratories
Architectural Aluminum Manufacturers Association - product certification related laboratories
Board of Accreditation Concrete Testing Laboratories - North Carolina
College of American Pathologists - human health related laboratories
International Electrotechnical Commission on Quality Assurance Systems - electronic component product certification related laboratories
National Kitchen Cabinet Association - product related certification laboratories
National Safe Transit Association - packaging testing laboratories
Ohio Association of Consulting Engineers - concrete testing labs - Ohio
Safety Glazing Certification Council - glazing products certification related laboratories
United States Potters Association - lead (and other substances) analysis laboratories

7. Information Sources Regarding Product Certification

The Office of Standards Information, Analysis and Development of the National Bureau of Standards, has tabulated 240 product categories for which certification programs have been established.[13] The tabulation lists the product category, the standards for which the products are certified, and the organization or laboratory responsible for the certification program.

The American Council of Independent Laboratories lists 233 laboratories in their 1980 directory of member laboratories. Of these laboratories, the ones listed in appendix D have included in their scope of activities specific product certification services. Some of the laboratories offer only certification testing services while others offer full management services for product certification programs.

The American National Standards Institute (ANSI) administers a program for the accreditation of product certification programs. This program is described in the ANSI publication, "American National Standards Institute Policy and Procedures and Manual of Operations for Accreditation of Certification Programs;" August, 1976. The publication presents statements of policy concerning ANSI accreditation of certification programs, ANSI certification committee procedures, procedures for the accreditation of certification programs, and a manual of operations for the accreditation of certification programs. The manual of operations defines the criteria established by ANSI for certification programs. Any agency or certifier who is planning a product certification program should consult this publication as a guide for outlining the essential elements of the program. Also, the ISO/CERTICO Committee on Certification[14] has published ISO Guide 16-1978(E) titled, "Code of Principles on Third-Party Certification Systems and Related Standards." This document provides generic criteria for third-party certification systems and should serve as a guide in the planning of any certification program that may include participation by foreign manufacturers or buyers.

8. Laboratory Accreditation and Product Certification Programs for Photovoltaic Systems

8.1 Introduction

The National Photovoltaic Energy Program of the Department of Energy was initiated in January, 1978, and is designed to expand the development and

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[13] Slattery, W.J.; "Tabulation of Voluntary Standards and Certification Programs for Consumer Products"; NBS Technical Note 948; June 1977. National Bureau of Standards, Washington, D.C. 20234.

[14] Mr. Daniel Chaucer, Chairman; Product Safety and Liability Consultant, 84-61 Furmanville Avenue, Rego Park, New York.

commercial use of photovoltaic (PV) systems as rapidly as possible through research, process development, testing and applications -- all in support of the manufacturing industry. The overall objective is to ensure that photovoltaic conversion systems contribute significantly to the nation's energy supply by the year 2000.

Within the broad scope of the National Photovoltaic Energy Program, the Solar Energy Research Institute manages the Performance Criteria and Test Standards (PC/TS) project. One of the tasks of this project is the development and implementation of procedures for qualifying PV product testing laboratories and PV product certification. To assist in that task, background information concerning laboratory qualifications and product certification has been provided in the ealier sections of the report. In this section, specific steps and procedures are provided to initite a program for evaluating testing laboratories and certifying PV products. These steps and procedures are divided into those that are for preparation and those that are for implementation. While these steps and procedures are presented with respect to photovoltaic products, in particular, they may be applied equally in establishing such programs for other products.

Of particular relevance to the PC/TS project is the need to identify which PV products need to be certified, establish product performance levels, and identify and develop standard methods for testing product performance to these levels. The associated decisions and actions to these needs must be taken before a laboratory evaluation and product certification program can be developed.

8.2 Preparation for the Test Laboratory and Product Certification Program

Before any program involving accredited laboratories, "approved" laboratories, or certification is initiated for photovoltaic products, a series of preparatory steps need to be taken. These steps are: (1) selection of products to be certified; (2) selection and development of product performance criteria, performance levels, and test methodology; (3) determination of the number of testing laboratories needed; (4) selection of the appropriate type of laboratory evaluation program; and (5) selection of the appropriate type of product ceritification program. The considerations, decisions, and actions associated with each of these steps are discussed below.

a. Selection of Products to be Certified

(1) Make preliminary selection of those products that need to be certified in the early stages of the proagram [products that may need to be certified in the later stages will need to be considered in c(2)];

(2) Develop justification for selecting the products in a(1);

(3) Determine whether any of the products in a(1) or their components are certified in other programs;

(4) Determine whether products certified in other programs are appropriate for the photovoltaic program;

(5) Based on step a(4), select those products identified in step a(1) that need to be certified.

b. Selection and Development of Product Performance Criteria, Performance Levels, and Test Methodology

(1) Determine what performance criteria the products must meet to be certified;

(2) Determine what product performance levels should be required for the product;

(3) Determine which existing test methods can be used to determine compliance with the criteria and performance levels in b(1) and b(2), respectively;

(4) Evaluate the test methods in b(3) for technical integrity and appropriateness;

(5) Develop test methods needed in addition to those in b(3);

(6) Identify the test methods to be used in the certification of photovoltaic products.

c. Determination of the Number of Testing Laboratories Needed

(1) Determine the number of laboratories that are capable of testing the products in a(5) in accordance with the test methods in b(6);

(2) Determine if the number of laboratories identified in c(1) is sufficient to conduct the certification and compliance testing of the products in a(5), (Note: The decisions made in this step may be influenced by the need for the certification of additional products in the later stages of the program. This additional certification testing may warrant a later change in program needs for qualified laboratories i.e.; a change, for example, from an "approved" laboratory program to an accredited laboratory program);

(3) If the number of laboratories in c(2) is insufficient to handle the required testing, determine the feasibility of promoting the expansion of the testing capability of the testing industry;

(4) If the expansion program in c(3) is feasible, initiate a program to establish the improved testing capability of the industry.

d. Selection of the Appropriate Type of Laboratory Evaluation Program

(1) Appoint a DOE/SERI[15] administrator to manage the selction of the appropriate laboratory evaluation program;

(2) Select the appropriate type of laboratory evaluation program, (Note: If the number of laboratories needed for a testing laboratory program is 10 or more, an accredited laboratory program should be chosen. If the number of laboratories is less than 10, an "approved" laboratory program will probably be best suited for the required testing):[16]

(3) Determine what portion of the program costs for examining and evaluating candidate laboratories shall be covered by fees charged to the laboratories;

(4) Determine whether independent laboratories or both independent and manufacturer's laboratories may be accredited or "approved" to conduct product testing (see the last paragraph of section 3.1);

(5) Verify the appropriateness of the decisions made in d(3) and d(4) through communication with NVLAP, AALA, or the selected "approved" laboratory evaluators and modify as necessary;

e. Selection of the Appropriate Type of Product Certification Program

(1) Appoint a DOE/SERI administrator to manage the selection of the appropriate product certification program [Note: This administrator may be the same person selected in d(1)];

(2) Determine[17] who will pay for the certification costs of the various product models submitted by manufacturers;

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[15] It is assumed that DOE and SERI will have overall responsibility for administering the photovoltaic laboratory testing and product certification program within those agencies. If it is decided that another organization will assume this responsibility, the name of that organization can be substituted for "DOE/SERI" when it is used here after in Section 8.

[16] In most cases, a laboratory accreditation program is not practical if the number of laboratories needed is less than 10 because of program implementation costs and proficiency testing limitations.

[17] The information on which to make this determination may be obtained directly by the DOE/SERI administrator or through a contractee.

(3) Determine[17] how samples of product models submitted for certification and compliance testing will be obtained;

(4) Determine[17] who will provide a warranty for certified products including repair or replacement of non-complying units;

(5) Determine[17] who will pay for past-certification monitoring and testing to insure compliance of certified products;

(6) Determine[17] whether the program should provide for separate certification of product models having different performance capabilities;

(7) Review and revise, if necessary, the decisions in e(2) through e(6) to insure that they will not inhibit the innovation or commercialization of photovoltaic products;

(8) Review the criteria established by ISO/CERTICO for product certification programs to insure compatibility of the photovoltaic certification program with the ISO/CERTICO criteria (See section 7.)

8.3 Getting a Program Started

Once the preparatory steps in the previous section have been taken, an organizational structure can be established to implement the laboratory testing and product certification activities. Such a structure is presented in figure 1 and will be used in some of the subsequent discussions in this section.

The DOE/SERI administrator appointed to manage (within the agency) the preparatory steps described in section 8.2 will have certain responsibilities that depend on the decision of whether to conduct product testing with accredited laboratories or with "approved" laboratories.

If the decision is made to use "approved" laboratories, the DOE/SERI administrator may delegate the responsibilities to a contractee who will serve as an executive program administrator. Such a contractee will need to be selected through the issuance of a request-for-proposal (RFP) which will define the program objectives and the contractee responsibilities for meeting those objectives. The selected contracts should be proficient in the management and implementation of laboratory evaluation programs.

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[17] The information on which to make this determination may be obtained directly by the DOE/SERI administrator or through a contractee.

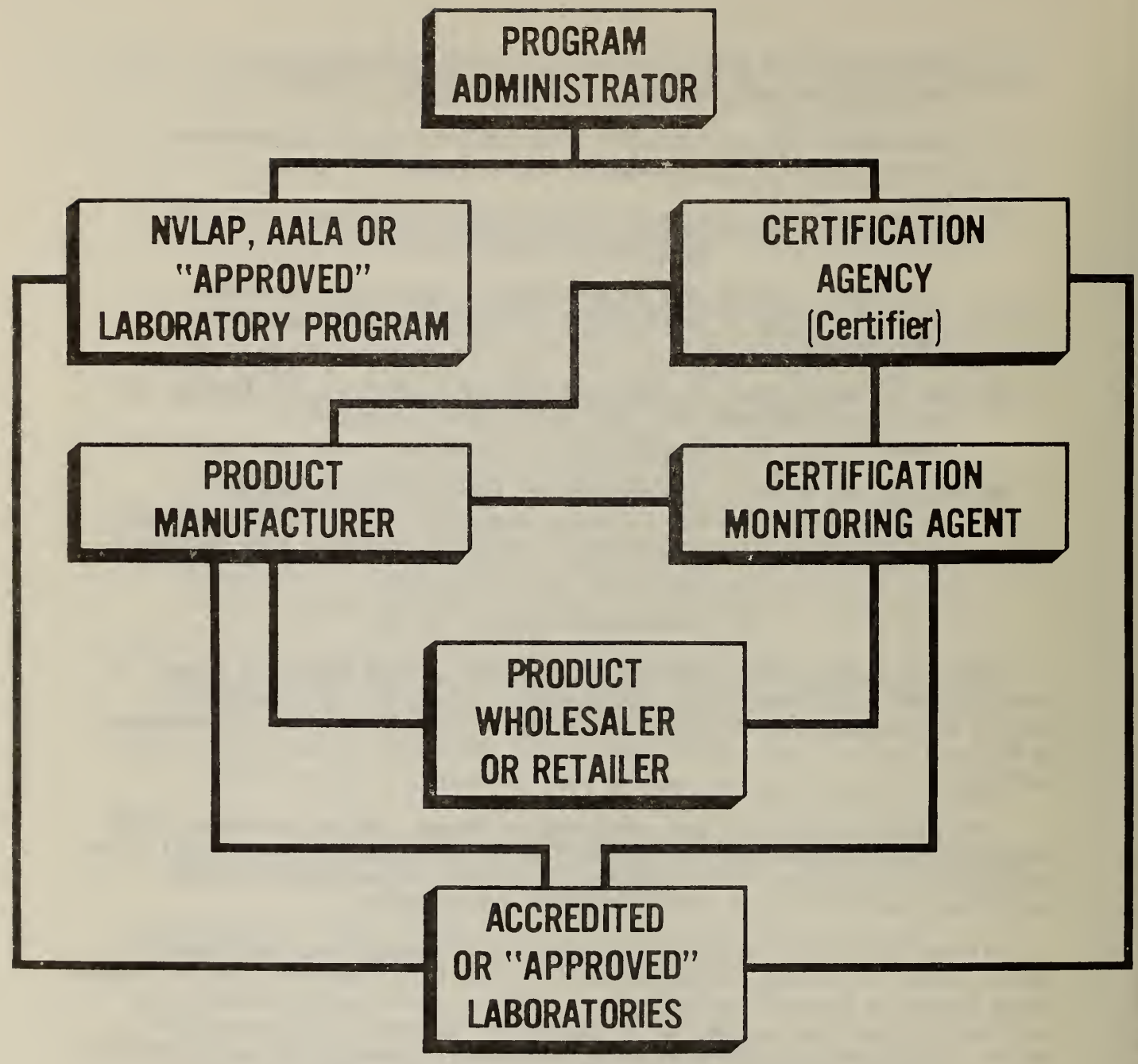

FIGURE 1: DOE/SERI PRODUCT CERTIFICATION SYSTEM

NOTE: The connecting lines indicate back-and-forth communication between system entities.

If the decision is made to use one of the two national programs for accrediting laboratories, it will be necessary to have direct communication between the DOE/SERI administrator and the administrator of the selected accreditation program to assure efficient implementation of laboratory evaluation activities. In this case, the responsibility for directing the program should not be delegated to a third party.

In requesting the development of an accreditation program, specific information must be furnished to the administrator of the selected program. For the American Association for Laboratory Accreditation program, a request for an accreditation program should be sent to:

American Association for Laboratory
Accreditation
P.O. Box 546
Palatine, Illinois 60067

A listing of documented test methods that accredited laboratories will be required to conduct should be included in the request. AALA may include these test methods in one of the existing testing disciplines listed in appendix C or a separate discipline may be established if the test methods are not appropriate for the existing disciplines.

For the Department of Commerce National Voluntary Laboratory Accreditation Program, if the requesting organization is a Federal agency, the request should be sent to:

Honorable Jordan J. Baruch
Assistant Secretary for Science
and Technology
U.S. Department of Commerce
Washington, D.C. 20230

The request should comply with the procedures presented in Title 15, Code of Federal Regulations, Part 7b. If the request is submitted by an organization of the private sector or a standards-writing organization, the request should be sent to:

Honorable Phillip M. Klutznick
Secretary of Commerce
U.S. Department of Commerce
Washington, D.C. 20230

For private sector organizations, the request should comply with the procedures presented in Title 15, Code of Federal Regulations, Part 7a. Standards-writing organizations should use the procedures in Title 15, Code of Federal Regulations, Part 7c.

A formal request for an accreditation program for a specific product must include a listing of documented test methods for which laboratories are to be accredited. For the photovoltaic program, it will not be necessary to list all test methods that may eventually be included in the advanced stages of the program. A list of test methods that the DOE/SERI administrator feels is essential in the initial stages of the program will be sufficient to initiate a NVLAP program. However, the list of test methods should be as complete as possible since any methods that are added after the program is initiated require a formal announcement in the Federal Register. A Federal Register announcement is generally followed by a public comment period and a public hearing, if such a hearing is requested. This process requires a considerable amount of time and expense and its use should be minimized.

With regard to the implementation of a certification program, a certification agency (certifier) will need to be selected. An RFP may be issued for selecting a certifier to manage and implement the certification program. The certifier can be an independent laboratory or any organization with the necessary personnel and experience required to effectively carry out the objectives of the program. The certifier will select a certification monitoring agent who will monitor all activities associated with the certification and compliance testing of products.

When a manufacturer wishes to have a product model certified, the manufacturer notifies the certifier of his intentions. The certifier, in response, sends a set of application forms to the manufacturer which describes the commitments between the certifier and the manufacturer concerning (a) fees for certification and compliance testing; (b) product samples to be furnished for certification testing; (c) product samples that the monitoring agent can obtain periodically from the manufacturer, wholesaler, or retailer for compliance testing; (d) warranty guarantees; and (e) the use of a certification label on product samples. The application forms would also require the manufacturer to furnish such information as:

(a) Product description
- Product name and serial number
- Product specifications and drawings
- Performance and rating test data
- Compliance with standards or specifications

(b) User information
- Installation instructions
- Operation instructions
- Safety instructions
- Maintenance instructions
- Input/output ratings
- Environmental limits
- Interface requirements
- Warranty provisions
- Parts lists

When the certifier accepts the manufacturer's request for the certification of a product model, an agreement is reach concerning the shipment of product samples by the manufacturer to either the certifier or an accredited or "approved" laboratory for certification testing. The agreement also establishes the procedures for the selection of samples from the manufacturer, wholesaler, or retailer by the monitoring agent for compliance testing by the laboratory. The certifier will also be responsible for establishing and keeping up-to-date a certified products list that would be available to agencies, organizations, or individuals who specify, buy, or use photovoltaic systems.

Appendix A. Additional Information on the Department of Commerce National Voluntary Laboratory Accreditation Program

1. Historical Background

The Department of Commerce National Voluntary Labortory Accreditation Program (NVLAP) was officially announced on February 25, 1976.

The first request to establish a laboratory accreditation program (LAP) was received by the Secretary of Commerce on December 1, 1976. The request was submitted jointly by three associations -- the Thermal Insulation Manufacturers Association, the National Mineral Wool Insulation Association, Inc., and the National Cellulose Insulation Manufacturers Association. The request emphasized the need for the accreditation of laboratories that test the various properties of thermal insulation materials. A second LAP request was submitted by the National Ready Mixed Concrete Association on March 20, 1978.

The Secretary established that there was a national need for accredited laboratories in these two areas of testing and appointed separate committees to establish laboratory criteria for each LAP. The members of each committee were chosen on a basis of achieving a balance between Federal, State, and local government interests and manufacturer, testing laboratory, and user interests. The established expertise of each member in his or her respective field was a strong factor in the selection. Each committee was charged with the task of recommending general and specific criteria which could be used for assessing the competency of laboratories seeking accreditation. The recommended criteria were published in the Federal Register for public comment and public hearings were held. The revised criteria become final and are now being used to evaluate laboratories.

2. Laboratory Evaluations

The decision to accredit a laboratory is based upon three factors: (1) information supplied by the laboratory, (2) observations by examiners during an on-site visit to the laboratory and (3) data obtained from proficiency tests periodically conducted by the laboratory.[1] The National Bureau of Standards is responsible for the examination and evaluation of applicant laboratories. Accreditation is granted by the Assistant Secretary of Commerce for Science and Technology acting on behalf of the Secretary of Commerce.

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[1] Not all test methods require proficiency testing.

3. Agreement by the Laboratory

As a condition for receiving and maintaining accreditation under the NVLAP program, a laboratory must agree to:

(a) provide questionnaire information that will enable NVLAP evaluators to assess the laboratory's capability to perform the tests for which accreditation is sought;

(b) allow on-site inspection of the laboratory prior to accreditation and on a periodic basis while in the program;

(c) participate in proficiency sample testing programs that may be required for maintaining accreditation;

(d) pay the accreditation fees and charges;

(e) avoid reference to NVLAP accreditation status and forbid the laboratory's clients from referencing the same in consumer media and product advertising, or on product labels, containers, and packaging. Accreditation status may be stated on letter-head stationery, in brochures, and in laboratory services advertising;

(f) limit any statements or references concerning NVLAP accreditation status to those specific test methods for which the laboratory is accredited.

4. Accreditation Fees

In NVLAP, the annual fees a laboratory pays generally depends on the number and complexity of the test methods for which it desires accreditation. In the thermal insulation LAP, the total annual fee, F, is determined by the formula $F = A + (B_1)(N_1) + (B_2)(N_2) + (B_3)(N_3) + (B_4)(B_4) + P$ where A equals \$750; B_1, B_2, B_3, and B_4 are the fees for four levels of test method complexity and are \$50, \$100, \$150 and \$200 respectively; N is the number of test methods for the respective complexity level; and P is a proficiency testing fee of either \$100 or \$120 (depending on the type of test). To give an example, if a laboratory wishes to be accredited for the three test methods ASTM C165, ASTM C136 and ASTM C335 which have complexity levels of B_2, B_1 and B_3 respectively; the annual fee is $F = \$750 + (\$100)(1) + (\$50)(1) + (150)(1) + (\$120)(2)$[2] or \$1290. Additional information concerning test methods and related fees for the thermal insulation LAP and other LAPs are presented in the Federal Register Notice of January 23, 1980; Volume 45, No. 16.

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[2] Test methods ASTM C165 and ASTM C335 require proficiency testing.

5. Monitoring of Accredited Laboratories

After a laboratory has been accredited under the NVLAP program, various measures are taken to assure that the laboratory maintains its level of proficiency. The proficiency tests associated with a specific LAP are designed to monitor each laboratory's ability to obtain correct test results. In the thermal insulation LAP, laboratories are required to conduct proficiency tests twice yearly for all but one of the seven test methods which require such testing. One test method requires proficiency testing once yearly.

The proficiency test results from each laboratory are analyzed and compared to a "target" value which represents an "average" of all participating laboratories or a value obtained by a reference laboratory.

For test methods that do not require proficiency testing, each laboratory is visited periodically on an unannounced basis by a NVLAP examiner. The examiner inspects test equipment and, when possible, observes the procedures for each test method of concern.

Under the NVLAP program, laboratories are granted accreditation on a one-year basis. At the end of the first and second years, the performance of each laboratory is reviewed by (a) analyzing the over-all proficiency test results covering the respective review period, (b) evaluating any compliants received by NVLAP administrators concerning the laboratory's performance, and (c) evaluating data and information acquired by NVLAP examiners during routine or unannounced on-site examinations. If the review indicates that the laboratory's performance has been acceptable, its accreditation is renewed for another year. At the end of each three-year period, the laboratory is fully evaluated to the same degree and detail as the initial evaluation used to establish its accreditation.

6. Special NVLAP Procedures for Federal Agencies and Standards-Writing Organizations

As previously mentioned, the procedures for the NVLAP program require the Secretary of Commerce to conduct a "finding of need" for a specific LAP after a formal request for the program is received. The "finding of need" process includes the acquisition of the information and data presented in Section 1 of this appendix and requires a Federal Register Notice that summarizes the "findings," a public comment period lasting 30 days after the publication of the Federal Register Notice, and a public hearing if requested by concerned individuals.

The total time required for the "finding of need" process depends on the complexity of the requested LAP but generally requires approximately four months. Since this process significantly extends the time required to fully implement a LAP, optional NVLAP procedures were developed which allow Federal agencies and standards-writing organizations to determine their own need for a

specific LAP. The procedures governing LAP requests from Federal agencies are presented in Title 15 CFR, Part 7b, March 9, 1979, and for standards-writing organizations as presented in Title 15 CFR, Part 7c, April 25, 1979.

The NVLAP optional procedures not only allow the requesting organization to determine the need for the program but allow it to recommend general and specific laboratory criteria to the Secretary of Commerce. All recommended criteria are expected to be compatable with existing criteria developed for the NVLAP program. If the proposed criteria differs significantly from the existing criteria, a detailed explanation of the reason for the deviation must be presented.

Appendix B. Additional Information on the American Association for Laboratory Accreditation Program

At the time of this writing, the American Association for Laboratory Accreditation (AALA) program is not operational and no laboratory evaluation criteria have been developed. However, this information is provided based on literature promulgated by AALA.

1. Disciplines of Testing

The AALA program defines a testing laboratory as any person, partnership, corporation, university, research organization, association, or government agency. Testing laboratories may be accredited for performing specific tests or groups of tests in nine disciplines. Some examples of specific tests associated with each discipline are listed in appendix C. The procedures for the accreditation of a single laboratory in two or more disciplines is similar to the process by which the Association accredits two or more separate laboratories.

2. Requirements (Criteria) for Accreditation

General and specific laboratory criteria for the various disciplines of testing were being prepared by AALA during the writing of this report. A spokesman for AALA stated that these criteria would be available in the latter part of 1980.

3. Membership and Accreditation Fees

Two basic fee structures are used to support the costs of operating the AALA program. The fees relative to Association membership are structured in accordance with four classes of laboratories. These classes and the respective fees are (a) corporate membership with annual dues of $25.00 per $100,000 of gross income with a minimum of $100 and a maximum of $2,000; (b) non-profit organization membership with annual dues of $25.00 per $100,000 of gross income with a minimum of $250 and a maximum of $1,000; (c) individual membership with annual dues of $50.00 and (d) educational institutions and governmental agencies membership with annual dues of $100.00. Accreditation fees are established by the board of directors.

4. Laboratory Assessment

Applicant laboratories are examined by inspectors who are selected from a panel of specialists in the disciplines for which accreditation is sought. During the on-site examination, the inspectors may ask for a demonstration of various tests or may wish to use specific items of equipment in order to judge

the capacity of the equipment. One of the requirements for accreditation is the calibration of the laboratory's test equipment and the traceability of those calibrations to the National Bureau of Standards.

If the evaluation of a laboratory shows that it conforms in all respects with the requirements for accreditation, the Accreditation Advisory Committee reports to the Council of the Association accordingly and accreditation is granted. If however, the evaluation reveals certain conditions of non-conformity, the accreditation of the laboratory may be granted on a provisional basis if the non-conformity is of a minor nature and can be remedied within a short time. If the non-conformity is of a complex nature, the Council may decide to defer accreditation.

5. Accreditation and Registration of Testing Laboratories

When the AALA Council directs that accreditation of a laboratory be granted, the Executive Director immediately reports the Council's decision to the person who signed the laboratory's application for accreditation in terms of an advisory which includes:

(a) complete details of the classes or subclasses of test for which accreditation is granted;

(b) the names of persons approved by the Council to sign AALA endorsed test documents issued by the laboratory;

(c) any restrictions involved, such as limitations in the range in which measurements may be made, accuracies to be quoted, equipment to be used for certain tests, or specified test methods to be followed;

(d) any conditions, in addition to the general conditions defined in the by-laws, which must be met immediately or continuously.

The Council's direction that accreditation be granted is implemented by issue of the Executive Director's letter of advice.

When accreditation is completed, AALA ceases to consider that the laboratory application for accreditation is confidential. It publishes, in its AALA Register of Testing Laboratories, complete details of the terms of registration. The AALA Register of Testing Laboratories has, for each accredited laboratory, a separate entry showing the name of the testing organization, the address of the laboratory, classification of the laboratory, discipline and categories of testing included in the accreditation, and the names of approved signatories.

Appendix C. Disciplines and Associated Tests for the American Association for Laboratory Accreditation Program

Acoustic and Vibration Measurement	acoustic and vibration equipment; acoustic and vibration characteristics of materials and assemblies; measurement of sound and mechanical vibration; dynamic balancing.
Biological Testing	biological, bacteriological and mycological tests on drugs, vitamins, and food water; industrial cultures.
Chemical Testing	agricultural materials and products; bitumens; cements; ceramics; clays; cosmetics; detergents; drugs; environmental chemistry; explosives; fats; foods; fuels; gases; leather; lubricants; metals; ores; paper; paints; petroleum products; plastics; rubber; solvents; textiles; waters.
Electrical Testing	calibration; testing of electrical equipment and appliances; electrical tests on materials; testing of electronic equipment.
Thermal Testing	thermometers and pyrometers; checking furnaces and ovens; thermal conductivity.
Mechanical Testing	construction materials; soils; cement, aggregates, concrete; bitumens, asphaltic materials; wood products; metals; product assemblies; calibration; fluid mechanics; performance testing; metallography.
Metrology	gauges; jigs and tools; length and angle standards; mass; volume and density; pressure; time.
Non-destructive Testing	radiography of materials and assemblies; ultrasonics for thickness and flaws; magnetic particle and penetrant flaw detection.
Optics and Photometry	lamp and lighting fittings; photometers; calibration of optical instruments.

Appendix D. American Council of Independent Labaoratories Which Provide Specific Product Certification Services

1. Approved Engineering Test Laboratories, Inc.
   15720 Ventura Blvd.
   Encino, California 91436
   (213) 783-5985

2. Bowser-Morner Testing Laboratories, Inc.
   420 Davis Avenue
   P.O. Box 51
   Dayton, Ohio 45401
   (513) 253-8805

3. Communication Certification Laboratory
   Research Park - University of Utah
   P.O. Box 8106
   Salt Lake City, Utah 84108
   (801) 582-5842

4. Electrical Testing Laboratories, Inc.
   Industrial Park
   Cortland, New York 13045
   (607) 753-6711

5. R. F. Geisser and Associates, Inc.
   32 Cedar Street
   P.O. Box 1245
   Dedham, Massachusetts 02026
   (617) 329-4430

6. Arnold Greene Testing Laboratories, Inc.
   East Natick Industrial Park
   6 Huron Drive
   Natick, Massachusetts 01760
   (617) 235-7330

7. Industrial Testing Laboratories
   2813 Eighth Street
   Berkeley, California 94710
   (415) 848-3746

8. Lancaster Laboratories, Inc.
   2425 New Holland Pike
   Lancaster, Pennsylvania 17601
   (717) 656-2301

9. MET Electrical Testing Company, Inc.
916 West Patapsco Avenue
Baltimore, Maryland 21230
(301) 354-2200

10. Miami Testing Laboratory, Inc.
1640 West 32nd Place
Hialeah, Florida 33012
(305) 822-1141

11. Scientific Control Laboratories, Inc.
3136 S. Kolin Avenue
Chicago, Illinois 60623
(312) 254-2406

12. Stilson Laboratories, Inc.
170 N. High street
Columbus, Ohio 43215
(614) 228-4385

13. Underwriters Laboratories, Inc.[1]
333 Pfingsten Road
Northbrook, Illinois
(312) 272-8800

14. United States Testing Company, Inc.
1415 Park Avenue
Hoboken, New Jersey 07030
(201) 792-2400

15. Value Engineering Laboratory
2550 Huntington Avenue
Alexandria, Virginia 22303
(703) 960-4600

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[1] Underwriters Laboratories, Inc. is not a member of ACIL but is listed here because of its experience in managing product certification programs.

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Solar Energy Research Institute
Golden, CO 80401

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15. SUPPLEMENTARY NOTES

☐ Document describes a computer program; SF-185, FIPS Software Summary, is attached.

16. ABSTRACT *(A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here.)*

This report provides information and guidelines for use in preparing and implementing a laboratory evaluation and product certificate program for photovoltaic products, as required in the Department of Energy's work plan for the National Photovoltaic Energy Program.

The report presents an overview of the advantages and disadvantages of laboratory accreditation and product certification including economic factors that should be considered for such programs. Detailed information is also provided on the two national programs for accrediting laboratories, the Department of Commerce National Voluntary Laboratory Accreditation Program (NVLAP) and the American Association for Laboratory Accreditation (AALA). Information on the California and Florida state programs for laboratory accreditation and product certification of solar collector systems is given as examples of programs that have been in operation for several years. The organization of these programs and the experience gained by the program administrators may be useful in designing and implementing a program for photovoltaics. Also, accreditation and certification programs which are operated by other Federal and State agencies or professional and trade associations are listed for reference purposes.

(continued)

17. KEY WORDS *(six to twelve entries; alphabetical order; capitalize only the first letter of the first key word unless a proper name; separated by semicolons)*

Energy conversion; laboratory accreditation; photovoltaics; product certification; solar collectors; solar energy

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(Abstract continued)

A number of steps are presented which need to be taken before any laboratory accreditation and product certification program for photovoltaics can be initiated. These steps include the selection of the photovoltaic products to be certified and the selection of pertinent performance criteria, levels of performance, and test methodology. Once these and other preparatory steps have been taken, a procedure is described to actually implement an appropriate program for photovoltaics.